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Technology Goals for Generation IV Nuclear Energy

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Generation IV Nuclear Energy

- ***Generation IV:***
  nuclear energy systems deployable by 2030
- ***Nuclear energy systems:***
  fission reactor, energy conversion, fuel cycle front-end and back-end facilities, manufacturing infrastructure
- ***2030:***
  Symbolic for innovation, time for R&D

Generation IV Technology Roadmap

- *Two-year effort to make a plan (complete Dec 2002)*
- *Use best minds from industry, government and academia*
- *Start as US initiative, internationalize, and finish as internationally endorsed roadmap*
- *Final product: R&D Plan for identifying and developing most promising concepts to deployment*
- *Anticipate NEA role as R&D coordinator*

Generation IV Technology Goals

- *Goals must*
  - *Capture mid-century vision of energy needs*
  - *Provide basis for evaluating nuclear energy systems and identify the most promising concepts*

Sustainability Goals
- *Resource inputs*
- *Waste outputs*
- *Nonproliferation*

Safety & Reliability Goals
- *Excellence*
- *Core damage*
- *Emergency response*

Economics Goals
- *Life cycle cost*
- *Risk to capital*

Goals, Criteria and Metrics

Goal:

A desired result or objective for the system, stated in very broad terms and without numerical values. May not eventually be achievable.

Criteria:

A measurable indication of performance relative to goal.
Examples:
'Efficient use of U'
'Small amount of waste discharged'

Metric:

A standard of measurement, i.e., a figure of merit.
Examples:
'U resource consumed per GWe-yr'
'Volume of discharged HLW per GWe-yr'

Guiding Principles

- *Technology goals for Generation IV systems must be challenging and stimulate innovation.*
- *Generation IV systems must be responsive to energy needs worldwide.*
- *Generation IV concepts must define complete nuclear energy systems, not simply reactor technologies.*
- *All candidates should be evaluated against the goals on the basis of their benefits, costs, risks, and uncertainties, with no technologies excluded at the outset.*

Caveats to the Goals

- *The goals will guide the development of new nuclear energy systems. The objective of Gen IV systems is to meet as many goals as possible.*
- *The goals are not overly specific because the social, regulatory, economic, and technological conditions of 2030 and beyond are uncertain.*
- *The goals must not be construed as regulatory requirements.*

Generation IV Technology Goals

- *The goals represent a consensus among those involved in the process*
- *Sustainability:*
  Ability to meet needs of present generation without jeopardizing ability of future generations to meet their needs
- *Safety and Reliability:*
  Essential priorities in the development and operation of nuclear energy systems
- *Economics:*
  Economic competitiveness is a requirement of the market place - essential element

Sustainability-1

SU-1: Generation IV nuclear energy systems including fuel cycles will provide sustainable energy generation that meets clean-air objectives and promotes long-term availability of systems and effective fuel utilization for worldwide energy production.

- *Use of fuel and special materials resources*
- *Atmospheric emissions*

Sustainability-2

SU-2: Generation IV systems including fuel cycles will minimize and manage their nuclear waste and notably reduce the long term stewardship burden in the future, thereby improving protection for the public health and the environment

- ***Minimization of radioactive waste streams***
- ***Environmental impact***
- ***Stewardship burden***

Sustainability-3

SU-3: Generation IV nuclear energy systems including fuel cycles will increase the assurance that they are a very unattractive and least desirable route for diversion or theft of weapons-usable materials.

- ***Proliferation resistance***

Safety and Reliability-1

SR-1: Generation IV nuclear energy systems operations will excel in safety and reliability.

- ***Frequent events***
- ***Worker and public safety during normal operations in all fuel cycle facilities***
- ***Reliability***

Safety and Reliability-2

SR-2: Generation IV nuclear energy systems will have a very low likelihood and degree of reactor core damage.

- ***Infrequent events***
- ***Initiating events***
- ***Prevention***
- ***Mitigation***

Safety and Reliability-3

SR-3: Generation IV nuclear energy systems will eliminate the need for offsite emergency response.

- ***Severe accidents***
- ***Insignificant radioactive releases***

Economics-1 and 2

EC-1: Generation IV nuclear energy systems will have a clear life-cycle cost advantage over other energy sources.

EC-2: Generation IV nuclear energy systems will have a level of financial risk comparable to other energy projects.

- ***Capital costs***
- ***Financial costs***
- ***Production costs***
- ***Development costs***
- ***Infrastructure costs***

Extras

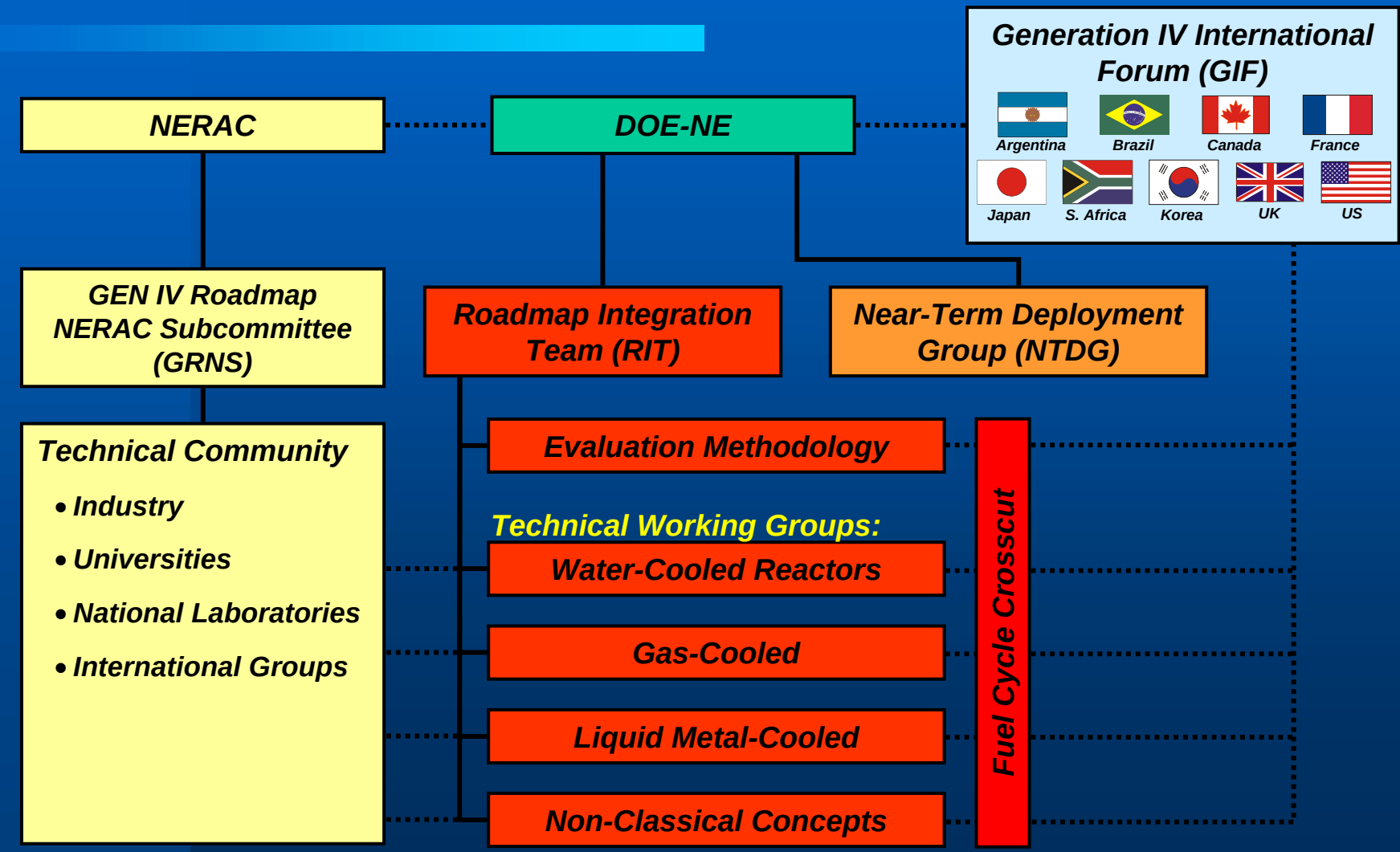
Request for Information (RFI)

- Broad call for concept ideas and baselines
- Open Mar 1 through April 15
- Important to draw wide international involvement
- Concept summary:
  - 5 page limit
  - 5 attachments permitted (<1 MB each)
    - reference list
    - analysis of concept performance
    - studies relevant to goals
- Available at http://gen-iv.doe.gov

Driving Forces for Gen IV

- *Large nuclear energy deployments by mid-century possible*
- *No new builds in US in many years, losing nuclear infrastructure*
- *Immediate future in US: technological and institutional barriers to near-term deployment of certified reactors (NTD)*
- *Future, worldwide: plan for developing advanced systems: Generation IV Roadmap*

Overall Roadmap Organization



Approach: Key Definitions

Gen IV System:

An entire energy production system, including the nuclear fuel cycle front and back end, the reactor, the power conversion equipment and its connection to the distribution system for electricity, hydrogen, process heat or fresh water, and the infrastructure for manufacture and deployment of the plant.

Generation IV systems are limited to those that can be certified before 2030. The system includes only critical fission-based reactors.

Concept:

An example of a Gen IV system with enough detail to allow evaluation against the goals, but broad enough to allow for optional features and trades.

Approach: First Steps

Derive technology goals based on industry needs

- Goals have been drafted by GRNS
- Captured in Technology Goals Document
- Goals will continue to evolve with comment

Plan the activity

- Roadmap Development Guide drafted by RIT
- Working groups have been convened
- International comment and participation

Determine how to measure concepts against goals

- Develop metrics for each goal
- Continue on to develop evaluation methodology
- Conducted by EMG, with the RIT and GRNS

Next Steps: Identify Concepts

Identify concepts for evaluation

- *Drawn from a broad international base*
- *Concepts adopted or synthesized by TWGs*

Detail the most promising concepts

- *Interactions between TWGs & concept teams/advocates*
- *Active study and comparison of underlying technology*
- *Evaluations guided by EMG metrics*

The Final Year: Evaluate & Assemble

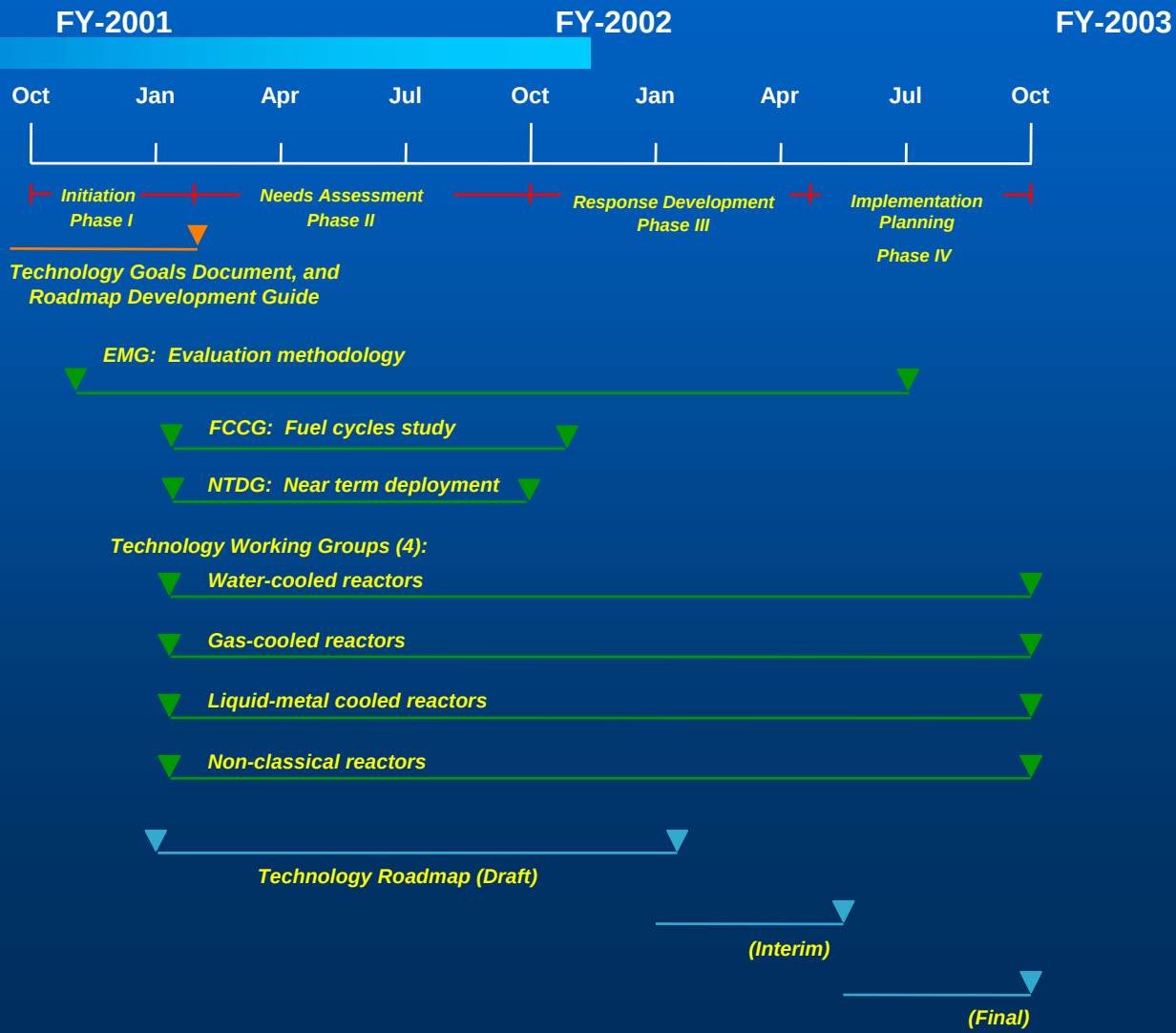
Evaluate the most viable concepts

- *Compare concept performance to goals*
- *Identify technology gaps*
- *TWGs lead – RIT/EMG reviews – DOE approves – GIF endorses*

Assemble roadmap to support the most promising concepts

- *Identify R&D needed to close gaps in areas of crosscutting technology*
- *Assemble a program plan with recommended phases*
- *Groups report – RIT integrates – DOE approves – GIF endorses*

Milestones on the Two-year Timeline



February, 2000

Schedule for Producing the Roadmap

Four Phases over Two Years:

Phase I: Initial work
Oct '00 – Jan '01 – Completed

Phase II: Needs assessment
Jan '01 – Oct '01 – Beginning

Phase III: Response development
Oct '01 – May '02 – Jan '02 Draft Roadmap
– May '02 Interim Roadmap

Phase IV: Implementation planning
May '02 – Sep '02 – Sep '02 Final Roadmap